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(54) **Missile guidance system**

(57) A guidance system for a missile 20 comprises an optical sight 1 for aiming at a target, a manually-operable control 8 to generate control signals for guiding the missile in response to commands of an operator, an optical tracker 2 for tracking the missile in flight the tracker being arranged to generate further signals representative of the actual missile displacement from the tracker axis, and means such as a cable 12 for transmitting signals to the missile to effect guidance, the system further including a predictor 2*c* to provide signals representative of a predicted missile displacement from the tracker axis in response to the operator commands, a comparator 2*b* for comparing the predicted missile displacement signals with the actual missile displacement signals and providing a signal representative of any error therebetween, and switch means 2*e*, 2*f* whereby the missile can be controlled initially by the operator and subsequently additionally or alternatively by signals representative of the error between the predicted and actual misssile displacements.

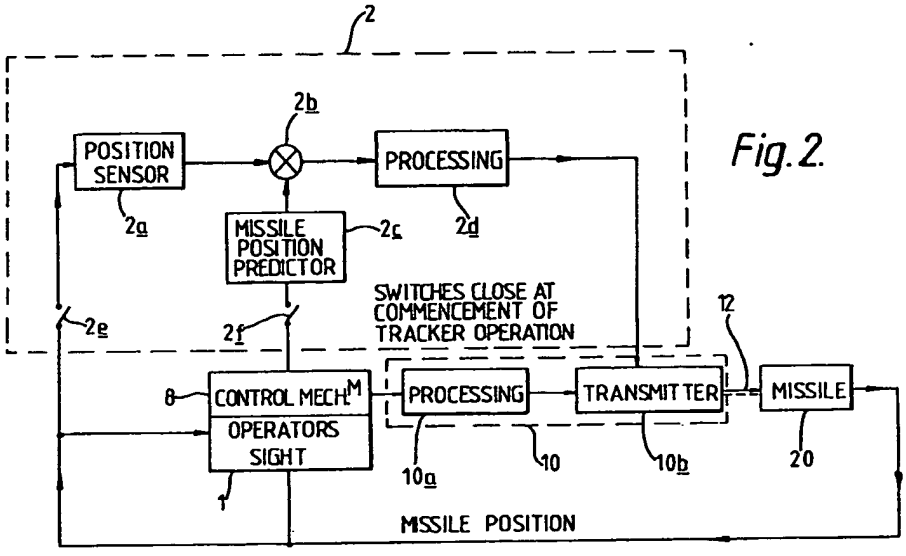

Fig. 2.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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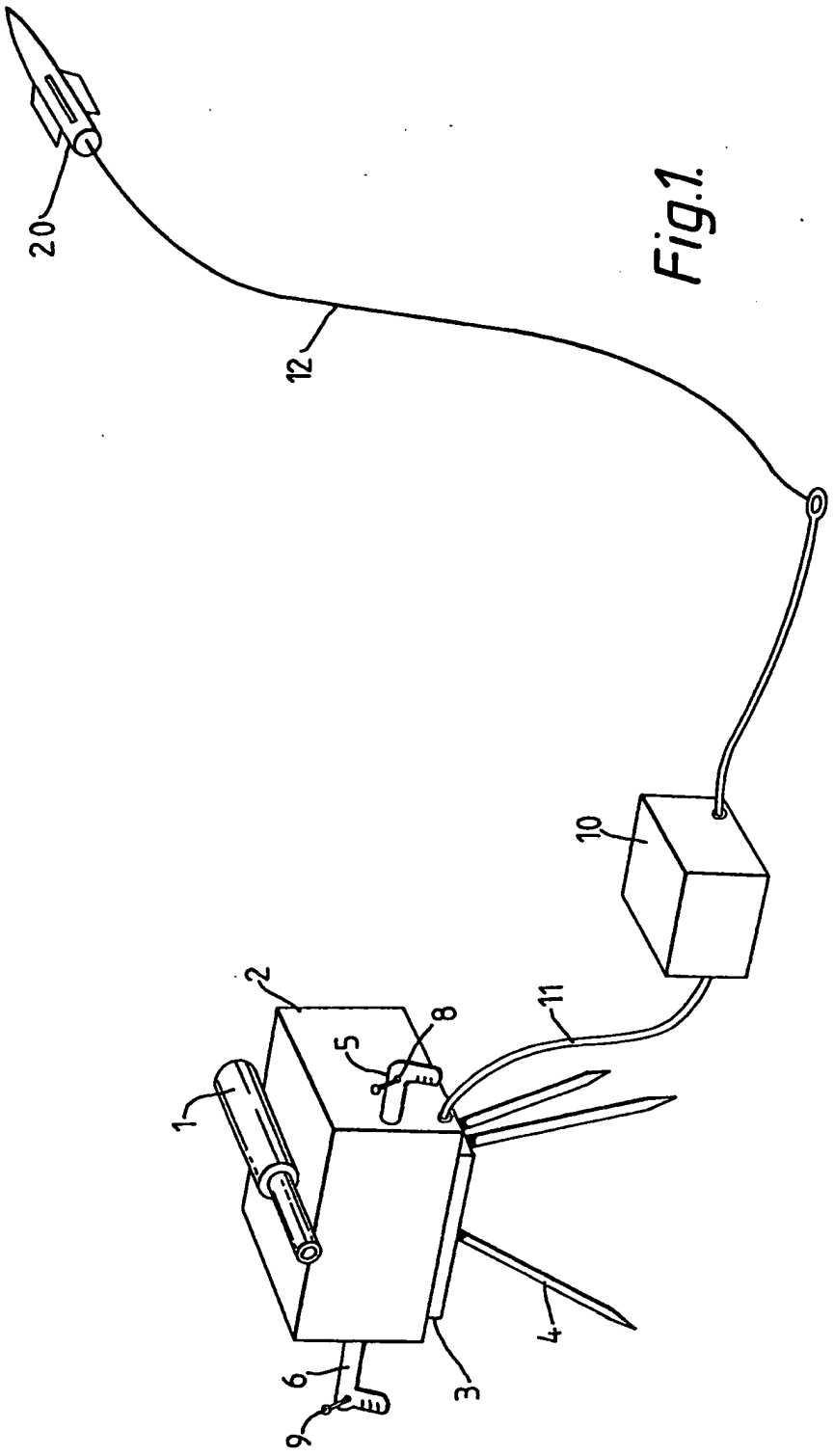
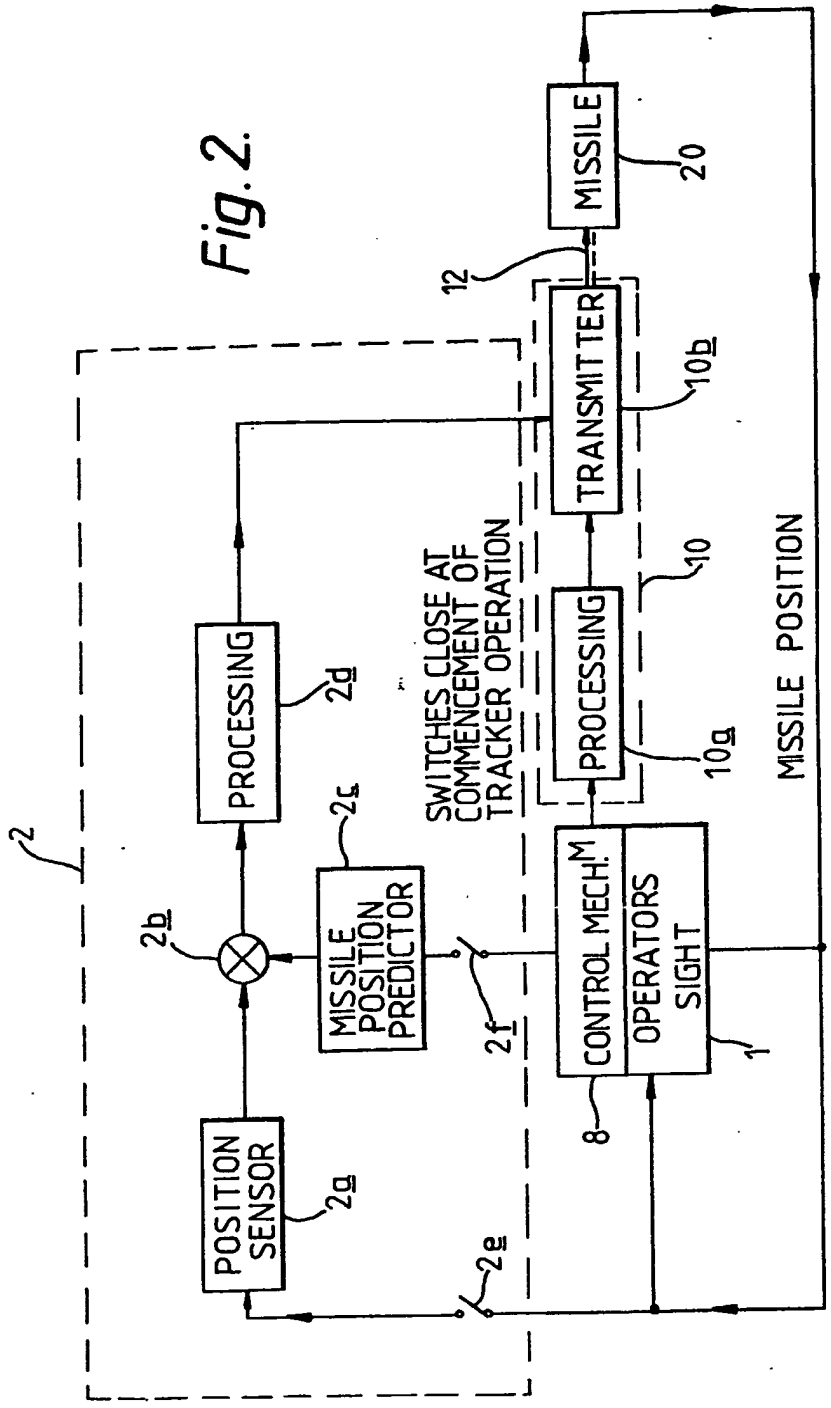


Fig.1.

Fig. 2.


MISSILE
20
12
TRANSMITTER
10b
PROCESSING
10a
10
SWITCHES CLOSE AT COMMENCEMENT OF TRACKER OPERATION
MISSILE POSITION
PROCESSING
2d
2c
MISSILE POSITION PREDICTOR
2b
2f
CONTROL MECH.M
OPERATORS SIGHT
1
8
POSITION SENSOR
2a
2e
2

SPECIFICATION

Missile guidance system

This invention relates to guidance systems for guided weapons, the guidance systems being of the type comprising an optical sight for aiming at a target, a manually-operable control to generate control signals for guiding the missile in response to command movements made by an operator, an optical tracker approximately aligned with the sight for tracking a missile in flight in the field of view of the tracker, the tracker being constructed and arranged to measure the actual displacement of the missile from the tracker axis and to generate further signals representative of that actual displacement for guiding the missile to reduce that displacement, and means for transmitting signals to the missile to effect guidance.

Hitherto such systems have suffered from two disadvantages namely:

(a) where automatic gathering after launch of the missile is provided for bringing the missile into the tracker field of view, due to the absence of manual control and the adaptability inherent in such manual control during the gathering period of flight, it is found that there is a high possibility of the missile striking the ground, and,

(b) it is found that missile movement, subsequent to gathering, produced by those control signals in response to command movements by an operator can produce control signals generated by the tracker which tend to nullify the operator's legitimate commands.

Thus an object of the present invention is to overcome these disadvantages. Moeover, it is a further object to overcome these disadvantages without major change to the apparatus of the guidance system.

According to the present invention, a guidance system of the type defined above includes predictor means constructed and arranged to provide signals representative of a predicted missile displacement from the tracker axis in response to the command movements of an operator, comparator means for comparing the predicted missile displacement signals with the actual missile displacement signals and providing a signal representative of any error between the predicted and actual displacements which, when transmitted to the missile, effects guidance so as to reduce that error, and switch means whereby the missile can be controlled initially by the control signals generated in response to command movements made by an operator, and subsequently additionally or alternatively by signals representative of the error between the predicted and actual missile displacements.

By this arrangement, the missile may be initially controlled by the operator using his manually-operable control for missile gathering purposes and, when the missile has been gathered and is in the view of the tracker, by the signal representative of the predicted and the actual displacements of the missile from the tracker axis. Conveniently, the control signal from the operator's manually-operable control is continued to be passed to the missile additionally to that derived from the predicted and actual displacements.

One embodiment of a guidance system is described by way of example with reference to the accompanying drawings in which:

Figure 1 is a general view of a combined manual and semi-automatic apparatus for controlling a missile;

Figure 2 is a schematic block diagram of a control system for supplying a missile with control signals using the combined manual and semi-automatic apparatus of Figure 1.

Referring to the Figures, a telescope sight 1 and a tracker 2 are fixed together and are rotatably supported by a pivotal mounting 3 upon a tripod 4. The telescope sight 1 and a tracker 2 have their optical axes generally aligned. A pair of handlebars, 5, 6 are fixed to the mounting 3. One handlebar 5 includes a joystick 8 for operation by an operator to supply flight control signals to a missile 20. A firing button 9 is provided in the other handlebar 6 in order that the operator may fire a missile at the appropriate time. A separate controller in a housing 10 placed alongside the tripod 4 is electrically connected to the joystick control 8 and the tracker 2 by means of a cable 11. The joystick 8 is able to generate first directional control signals for transmission to the missile 20 for controlling the flight of the missile, and these first signals from joystick 8 are applied via cable 11 to an electrical shaping unit 10*a* in the controller housing 10, which unit suitably modifies the signals and supplies them to a transmitter 10*b* also positioned within the housing 10, for transmission via a trailing cable 12 to a receiver mounted in the missile 20. The first signals received by the receiver are employed to control the operation of the actuators of the appropriate control surfaces of the missile 20. The tracker 2 is for example of the known kind including a position sensor 2*a* having a photo-electric screen on which a real optical image of the missile exhaust, or of a flare carried by the missile, is focussed, the position sensor producing signals corresponding to the co-ordinates of the displacement of the missile image on the photoelectric screen from the electrical centre of the screen. These signals are passed to a comparator 2*b*. The signals generated by the joystick 8 are fed to a missile position predictor 2*c* (item 2*c*, together with the comparator 2*b*, is an addition to the known tracker) which performs a signal processing of the operator's commands to determine the trajectory, that is to say the position at any instant, produced by an idealised, noise free, missile response. The signals corresponding to the predicted position obtained from the predictor 2 are passed to the comparator 2*b* where they are compared with those received from the position sensor 2*a*, that is to say those signals corresponding to the actual position of the missile, to provide an error signal which is modified by a processing device 2*d* to be transmitted to the missile by the transmitter 10*b* as second control signals. The missile is guided so as to remove the error.

Switches 2*e* and 2*f* are provided to isolate the position sensor 2*a* and the position predictor 2*c*.

In operation, in order to gather a launched missile into the field of view of the tracker 2, an operator views missile motion with his sight 1 and by manipulating the joystick 8 can effect manual control of the missile 20 by way of items 10*a*, 10*b* and 12. The switches 2*e* and 2*f* are open so that missile control is by the first manual control signals only.

At some suitable point in time when the missile is gathered, the tracker is activated by closing switches 2*e* and 2*f* whereby missile control is effected additionally or, alternatively, by the second control signal derived from the signals from position sensor 2*a* and the position predictor 2*c* as compared at 2*b* and processed at 2*d*.

In summary, with the presently described arrangement an operator may manually gather the missile into the tracker field of view. Subsequently, his joystick commands are sampled and used to predict a demanded missile position. It is the error between this predicted position and the actual position sensed by the tracker which is used to control the missile preferably in addition to but possibly as an alternative to the operator's manual commands. Thus the operator is given a task very similar to that in a noise-free purely manual system since displacements of the missile from the predicted position due to disturbances and biasses are compensated by the second signals. No special alignment is required between the sight and the tracker since exact alignment is not a requirement, and thus no significant modifications to existing units are necessary.

At any time after gathering the operator can remove his hand from the joystick and the missile will remain where it is in the field of view, so that if the target is static the operator has only to place the missile on the target and the task is complete. If the target is moving, the tracker (through the second control signals) still acts to remove all disturbances and biasses, and the operator simply has to maintain the missile on the targer using his joystick (through the first control signals).

CLAIMS

1. A guidance system for a guided missile comprising an optical sight for aiming at a target, a manually-operable control to generate control signals for guiding the missile in response to command movements made by an operator, an optical tracker approximately aligned with the sight for tracking a missile in flight in the field of view of the tracker being constructed and arranged to measure the actual displacement of the missile from the tracker axis and to generate further signals representative of that actual displacement, and means for transmitting signals to the missile to effect guidance, the system further including predictor means constructed and arranged to provide signals representative of a predicted missile displacement from the tracker axis in response to the command movements of an operator, comparator means for comparing the predicted missile displacement signals with the actual missile displacement signals and providing a signal representative of any error between the predicted and actual displacements which, when transmitted to the missile, effects guidance so as to reduce that error, and switch means whereby the missile can be controlled initially by the control signals generated in response to command movements made by an operator, and subsequently additionally or alternatively by signals representative of the error between the predicted and actual missile displacements.

2. A guidance system substantially as described, with reference to Figure 2 of the accompanying drawings.

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